GLOBAL RUBBER CONFERENCE 2013

Guayule & R.Dandelion sebagai bahan bakou alternatif dari karet alami

Status, Tantangan, Peluang

S.Palu / D.Pioch/ T.Chapuset/ D.Snoeck/ E.Tardan/ F.Bonfils[1], A.Amor[2], M.Dorget[2] , S.Suchat[3] ,N.Sfeir[4]

1=CIRAD, 2=CTTM, 3=PSU-Thailand
4 = IAMM-CIHEAM

Global Rubber Conference 2013, Novotel Palembang, Indonesia, 1 – 3 October 2013

GLOBAL RUBBER CONFERENCE 2013

Guayule & R.Dandelion as alternative feedstock of natural rubber

Status, challenges, opportunities

S.Palu / D.Pioch/ T.Chapuset/ D.Snoeck/ E.Tardan/ F.Bonfils[1], A.Amor[2], M.Dorget[2] , S.Suchat[3] ,N.Sfeir[4]

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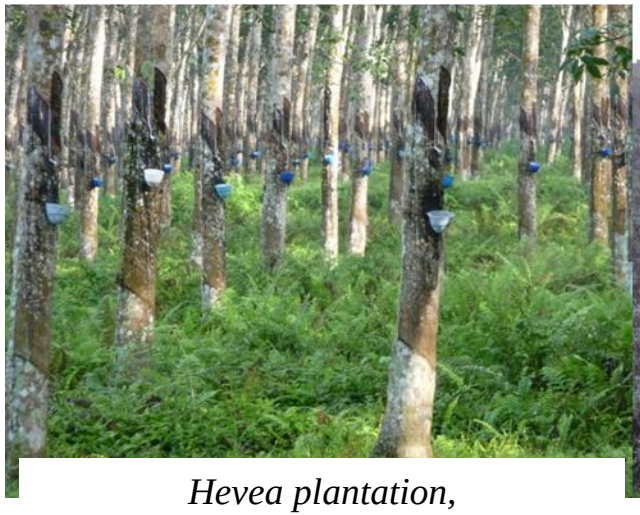
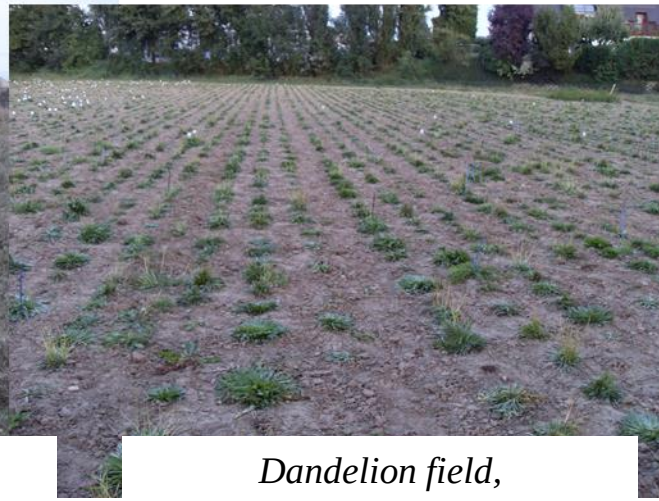
CONTENTS

1. ALTERNATIVES SOURCES OF NR SUPPLY. WHY ?
2. GUAYULE & R. DANDELION DEVELOPMENT AND HISTORY
3. AGRONOMY OF GUAYULE
4. COMPARISON LATEX TISSUS & CELLS HEVEA / GUAYULE / DANDELION
5. PRODUCTION
6. RUBBER PROPERTIES & APPLICATIONS
7. CONCLUSION & PERSPECTIVES

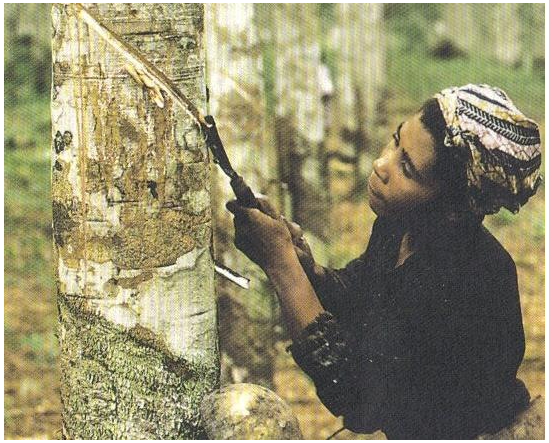


Hevea plantation,
Tropical climate *(>0°C >1500mm)*

Guayule field,
Mediterranean/semi-arid climate
(>-10°C 250-800 mm)



Dandelion field,
Temperate/cold climate
(-30°C, 800-1000 mm)



*Hevea ,**manual***

*Guayule,Dandelion, **mechanical***

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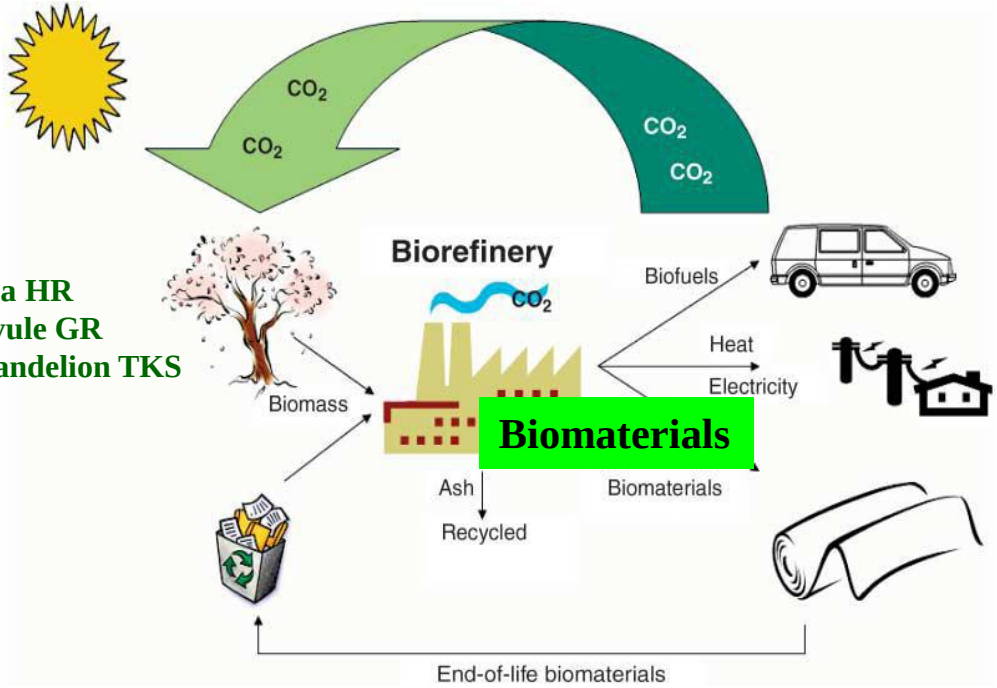
NR from Hevea, Guayule and Dandelion SUSTAINABLE polymers BIOREFINERY models

Hevea HR
Guayule GR
R. Dandelion TKS



BIOREFINERY CONCEPT

SUSTAINABILTY
SR versus NR

SYNTHETIC RUBBER	NATURAL RUBBER
	Excellent Hysteresis
	Low heat build-up
3.7 -5.0 Toe per ton SR	0.4 Toe per ton NR

1Toe/Tep =42GJ

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WHY NR ALTERNATIVES SOURCES ?

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- ***HEVEA*, only commercial source of NR (93% world prod. in Asia)**

  Growing demand from emerging countries (China, India,..).

  5.0 M. Tons in 1990 → ***17.0 M.T. in 2025 ?***

  Indonesia 2nd World Produced

- **Price NR & SR linked with volatile price of oil (80-150 $/ barrel)**
  NR prices will rocket upward again (4.800€/T. *in Feb. 2011*).

- **Replacement of rubber plantations by palm oil plantations ?**

- **Threat *Microcyclus ulei* (SALB) to spray in Asia/Africa. Climatic changes ?**

- **Increasing demand for sustainable materials, biopolymers.**

- **Hevea proteins and IgE-latex allergy. Cross allergy with fruits**

  → **Guayule hypoallergenic.**

HOW TO GUARANTY NR SUPPLY

- **New plantations & more replanting**
  8.3 M. ha in production, 11.4 M. ha with young planting.

- **Improve SALB Hevea clonal resistance (*IRRDB research*)**

- **Develop new alternatives sources**

  - ✓ GUAYULE (Parthenium argentatum Gray)
  - ✓ Russian DANDELION (Taraxakum kok saghyz)

- Implement European or International projects

  - ✓ **EU-PEARLS (2008-2012)**

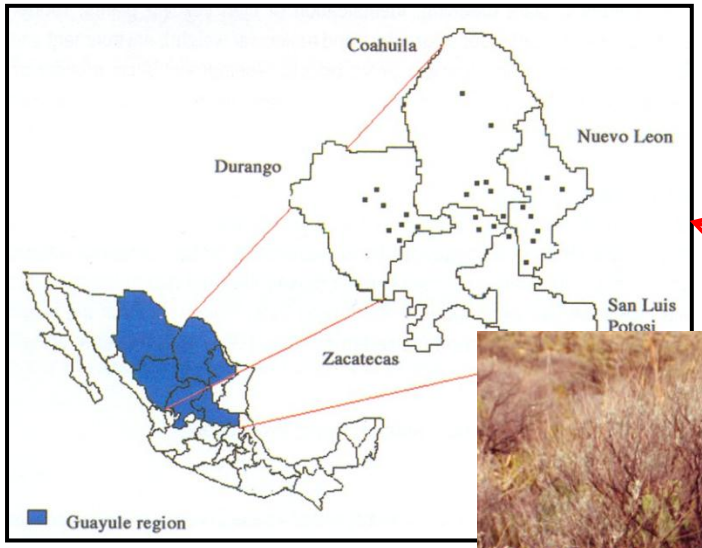
WHAT IS GUAYULE ?

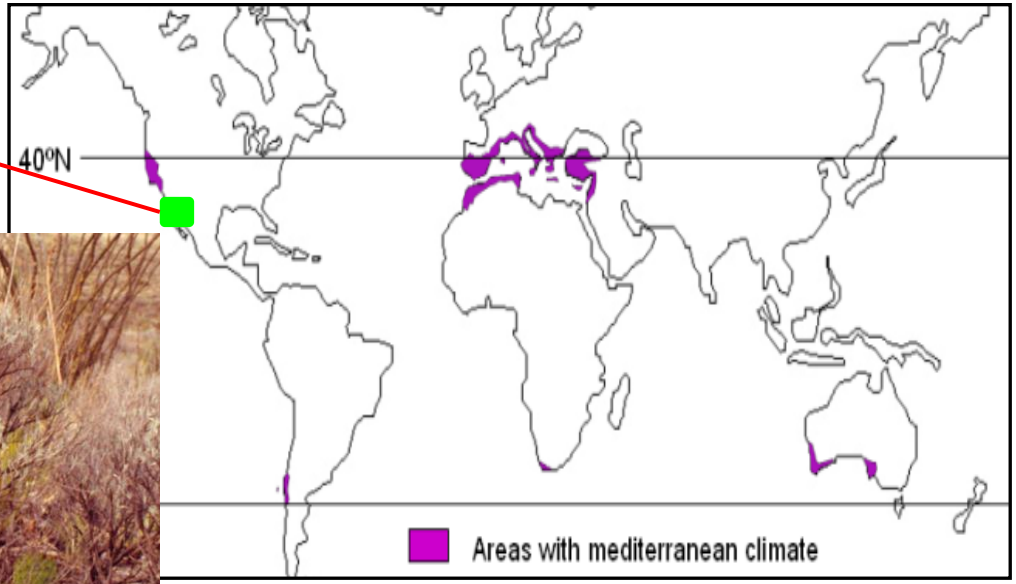
A bush, native from Mexico/Chihuahua semi-arid desert

(from the Aztec : quahu + ule ou olli / hayolli – hayule)

Asteraceae /Compositae **(*Parthenium argentatum Gray)***

in the wild, life up to 40 years; commercial up to 10 -12 years



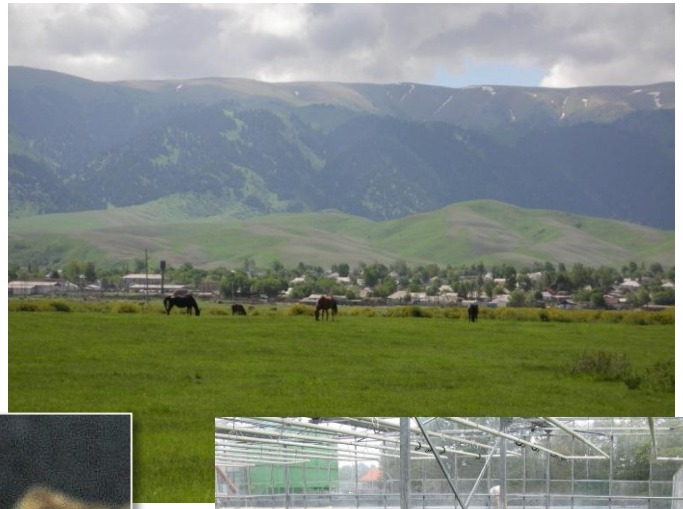


WHAT IS RUSSIAN-KAZAKHSTAN DANDELION ?

Native from Kazakhstan,

Asteraceae (Taraxacum kok saghyz)

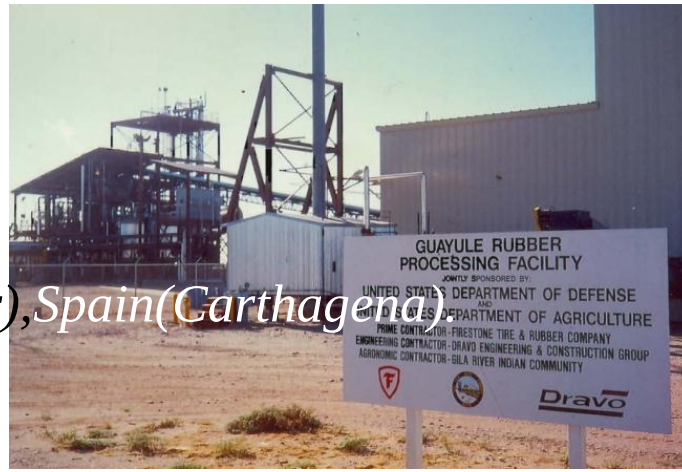
annual plant, wild &commercial (?),cold (-30°C) & heat (+40°C)



Photos U.Munster(GER) & J.Kirshner

HISTORY, DEVELOPMENT OF GUAYULE

- 1906-1912: *55.000 T. of GR, < 1000 T. hevea plantations at same period,*
- Emergency Rubber Project (WWII): *8,000 ha in the US, stopped with end of war with access to hevea plantations in Asia and synthetic rubber development,*
- 1970-1980s: *Oil embargo. Pilot plant Saltillo, Mexico. Firestone plant, Sacaton USA. IRCA/CIRAD, Morocco & West Africa,*



- 2000s, YULEX: *Guayule hypoallergenic latex (K.Cornish)*
- 2008, EU-PEARLS: *Guayule, France (Montpellier), Spain (Carthagena), TKS in Germany, The Netherlands, Spain.*
- 2012-2013: *Bridgestone project. Yulex new factory in USA. Cooper Tire project with Yulex. Bridgestone interest for GR bioproducts. Yulex with VERSALIS & PIRELLI in Italy. PANARIDUS in India. Europe, follow up of EU-PEARLS ?*

HISTORY, DEVELOPMENT OF R.DANDELION

- **WWII:** *100.000 ha in the ex-URSS, 540.000 ha in Germany*
- **2008:** *Ohio (USA), PENRA project. EU-PEARLS project*
- **2012:** *NovaBioRubber Green Technologies (Canada). Patent TKS rubber. Continental interest for tires with TKS rubber.*
- **2013:** *Bridgestone & Ohio State University, claim TKS commercially viable, renewable source of tire-grade rubber.*
  Project TAKOWIND in Germany for commercial development in 2016.
- **2015:** *Novabiorubber & Universities Canada , industrial plant of TKS rubber*

AGRONOMY OF GUAYULE

- Commercial conditions: soils <u>well-drained</u>, 12 years, -9°C$_{minimum}$, 380-800$_{mm}$. Needs irrigation, nursery plants, high density planting (30.000 to 55.000 plants/ha).

➡ **More biomass ≈ more rubber**

- Guayule lines: apomitic, tetraploids most common form, bigger plants, more productive. USDA lines: AZ1, AZ2, AZ3, CAL 6, 11591, N565, old 593 (IRC/ERP)

➡ **Rubber content 6–12%** (dry weight biomass)

81% of rubber in branches, 18% in roots, 1% in leaves,

➡ **Expected yield ≈ 0.5-1.0 kg/ha/an**

Harvest after 2 years versus 6-8 y. for hevea,

Every 1-2 years for 12 years before replanting, instead of every 2 days S/2,D2.

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GUAYULE CULTIVATION

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Photos EU-PEARLS project France & Spain

CONTROL OF RUBER & RESINS CONTENT BY NIRS METHOD

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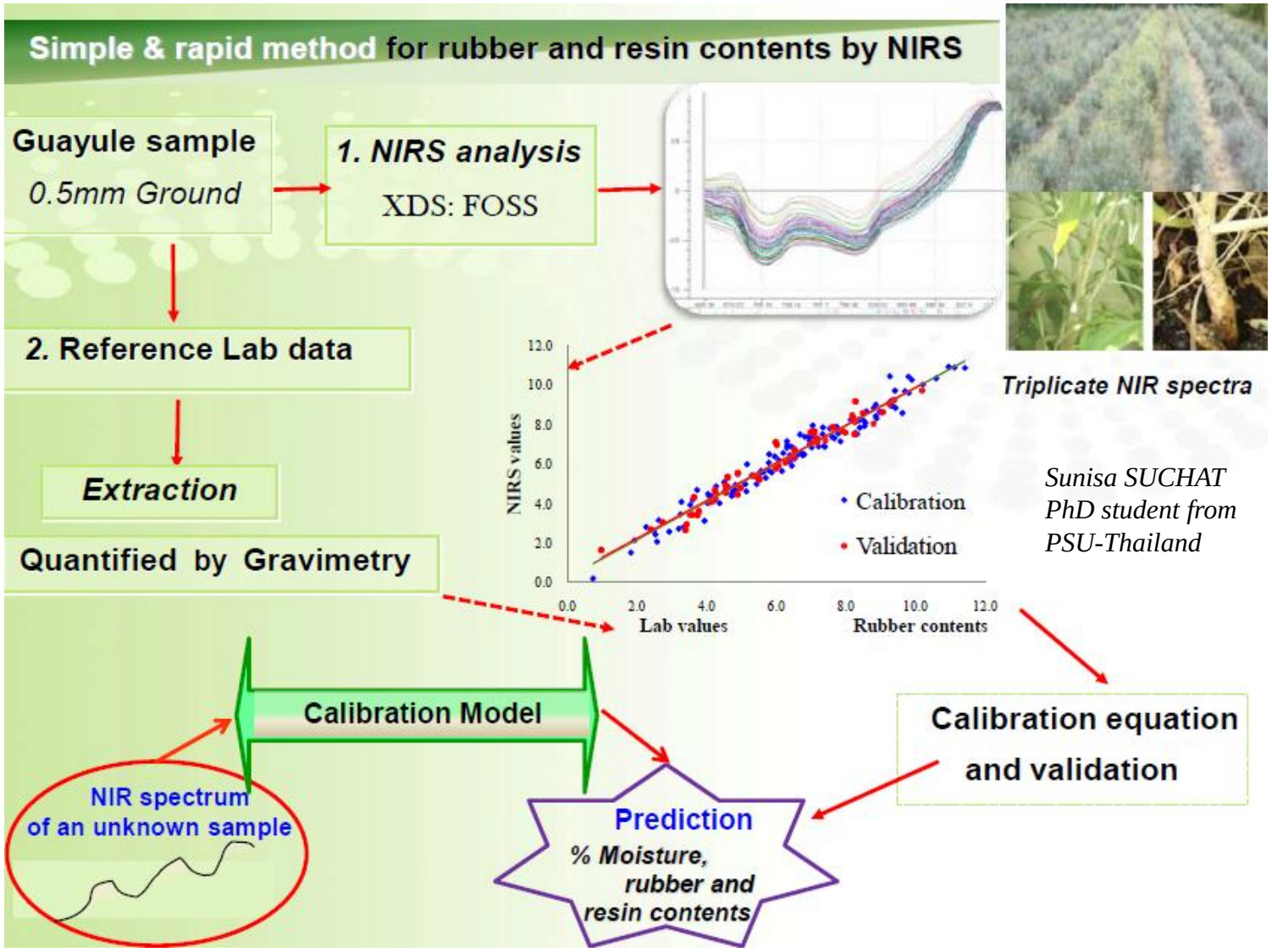

Sunisa SUCHAT
PhD student from
PSU-Thailand

POSSIBILITY TO GROW GUAYULE IN INDONESIA ?

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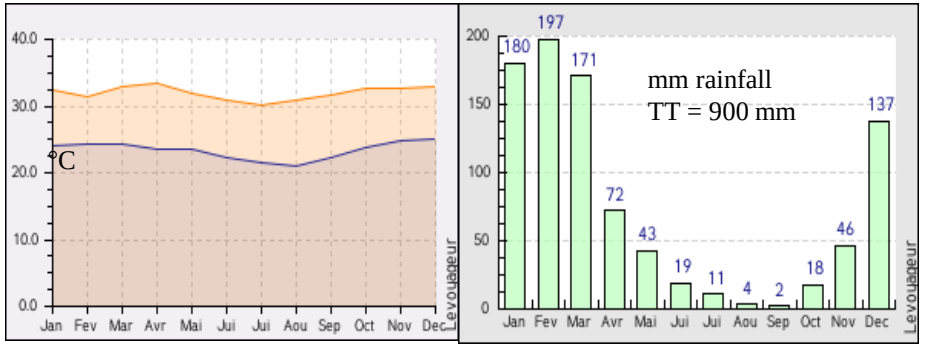
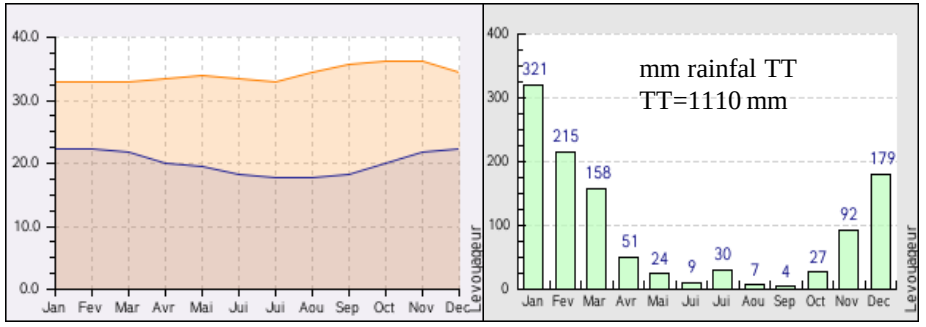
Waingapu



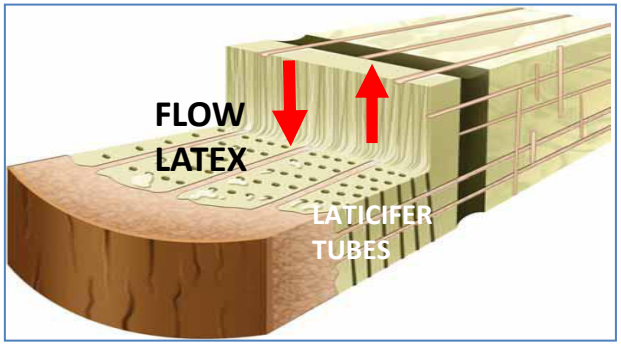


Kupang

HISTOLOGY LATEX CELLS/TISSU

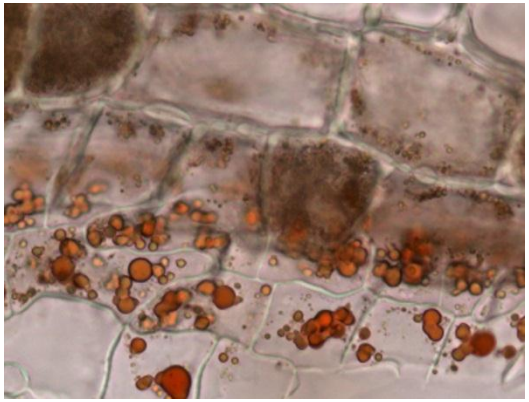
HEVEA

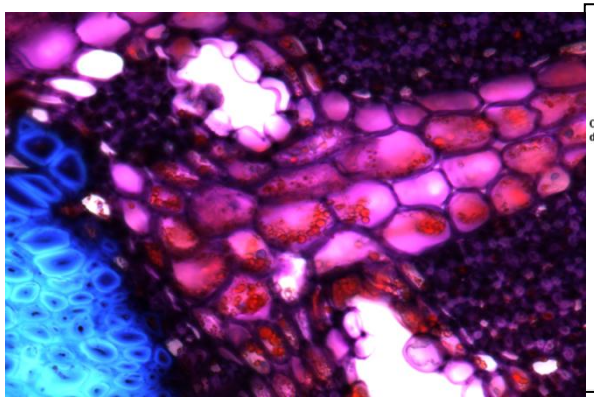
Latex ducts with connections

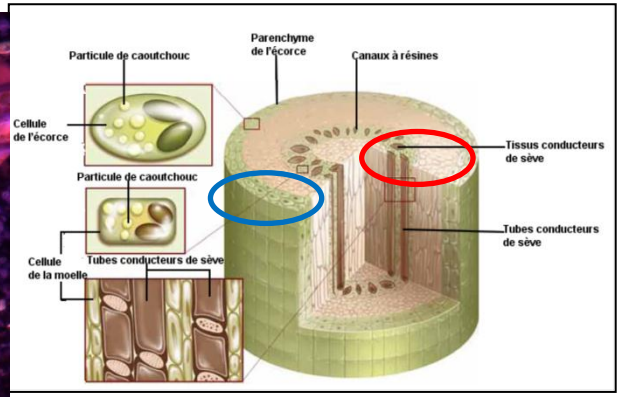


GUAYULE

Latex in individual cells







R.DANDELION

Latex vessels similar to Hevea,

no connection between latex vessels.

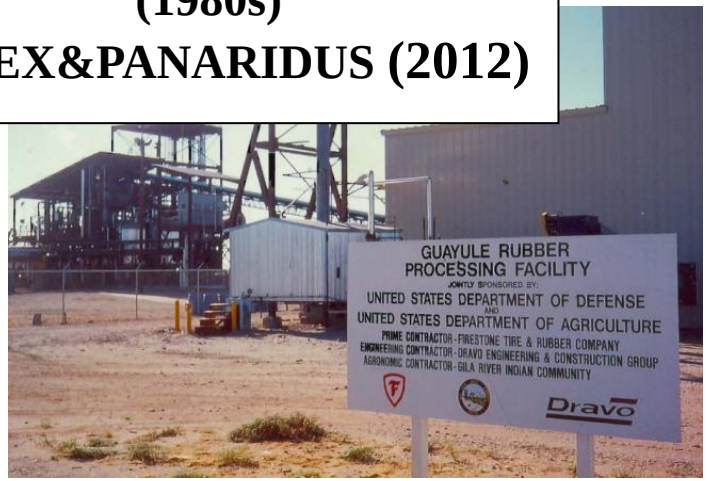
EXTRACTION PROCESS
NR GUAYULE

HARVEST

LATEX	SOLVENT DRY RUBBER & RESINS	SC FLUID RESINS & Low Mw
YULEX USDA CIRAD	SALTILLO (Mexico) TEXAS A&M FIRESTONE/SACATON (1980s) YULEX&PANARIDUS (2012)	USDA,YULEX CIRAD Laboratory

RESEARCH LEVEL

COMMERCIAL (500 T./Y)



COMMERCIAL PILOT

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MODEL GUAYULE LATEX EXTRACTION

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EXTRACTION PROCESS TKS

HARVEST (annual)

WET PROCESS LATEX

Soviet Tech (1936).
ESKEW (1940)
PENRA process (2012)
Primary, Secondary
Milling Screening,
Centrifuging Flotation

DRY PROCESS RUBBER

NovaBioRubber
25°C, mechanical, green additive (US Patent #7,540,438)
200 T./Y.

Source OHIO State U.OARDC

PILOT LEVEL

WHY NATURAL RUBBER STILL COMPETE ?

➢**NR cannot be replaced by SR in some applications**

TSR/RSS:

-Heavy duty tyres (e.g. airplanes, agricultural)

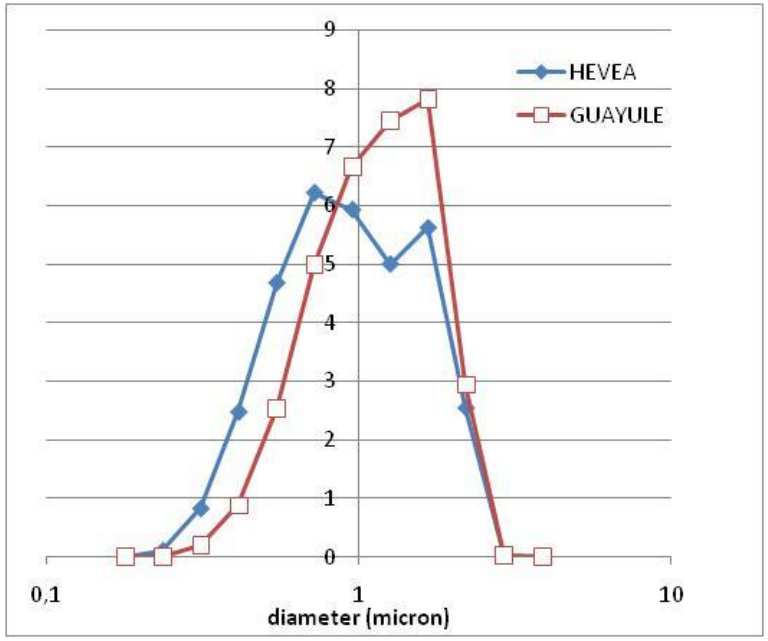
-low heat build up
-high resiliency
-resistance to break
-high tear and tensile strength
-green strength

Latex applications :

- Gloves, condoms

Guayule latex no allergy

LATEX PROPERTIES



	HEVEA LATEX	COMMERCIAL GUAYULE LATEX*
Solid content (%)	**61.4**	**55.6**
Viscosity (Cp)	**48**	**53**
pH	**9.6**	**10.9**
Average size (µm)	**1.0**	**1.2**

GLOVES PROPERTIES

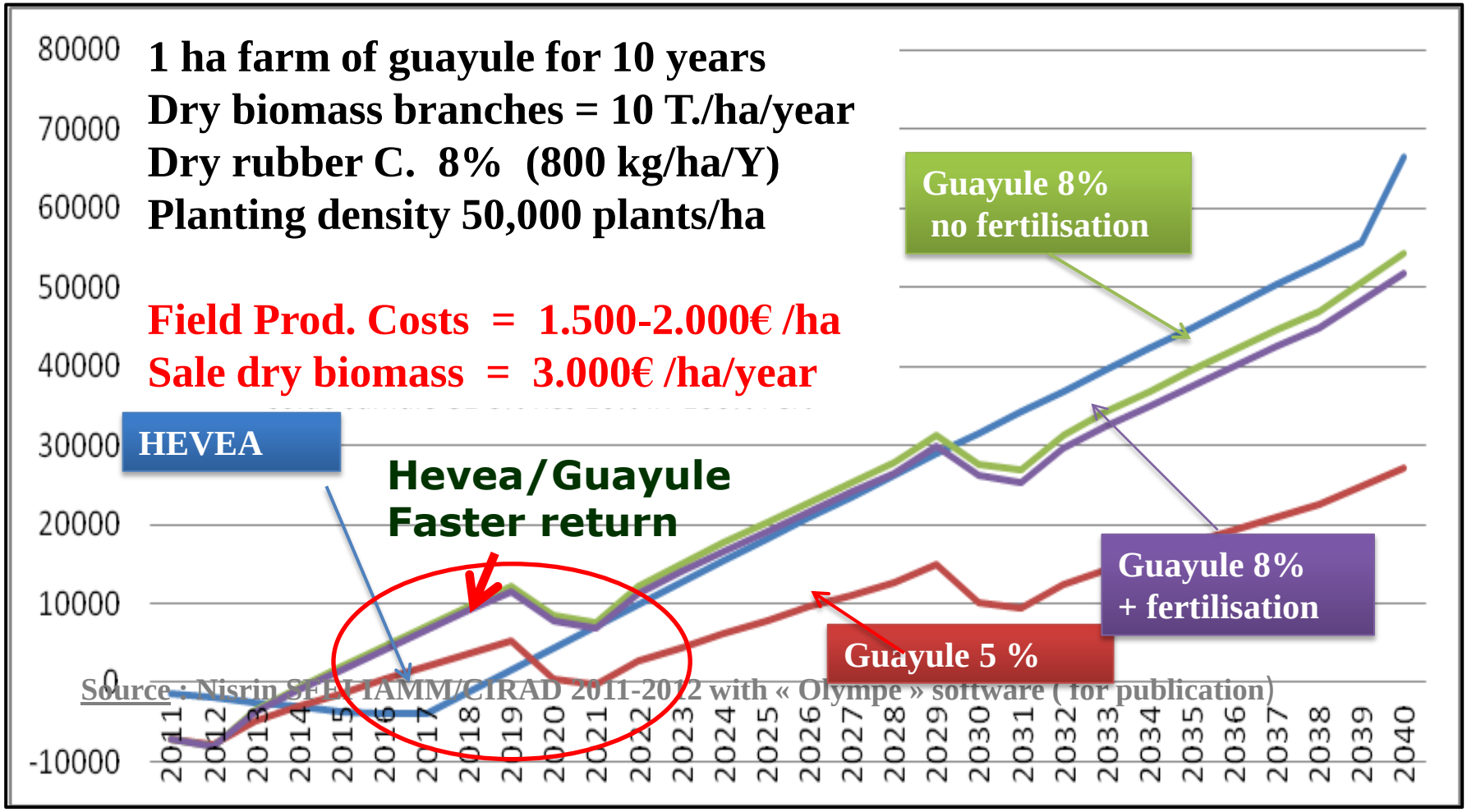
	HEVEA latex	COMMERCIAL GUAYULE latex	EU-PEARLS GUAYULE light phase latex	
Vulcanising dispersion ratio	27	54	54	
Stress at break (Mpa)	17	7.0	13.3	
Strain at break (%)	810	860	808	

GUAYULE and HEVEA gloves mechanical properties are similar after slight formulation and process adaptations

GR TSR SPECIFICATIONS

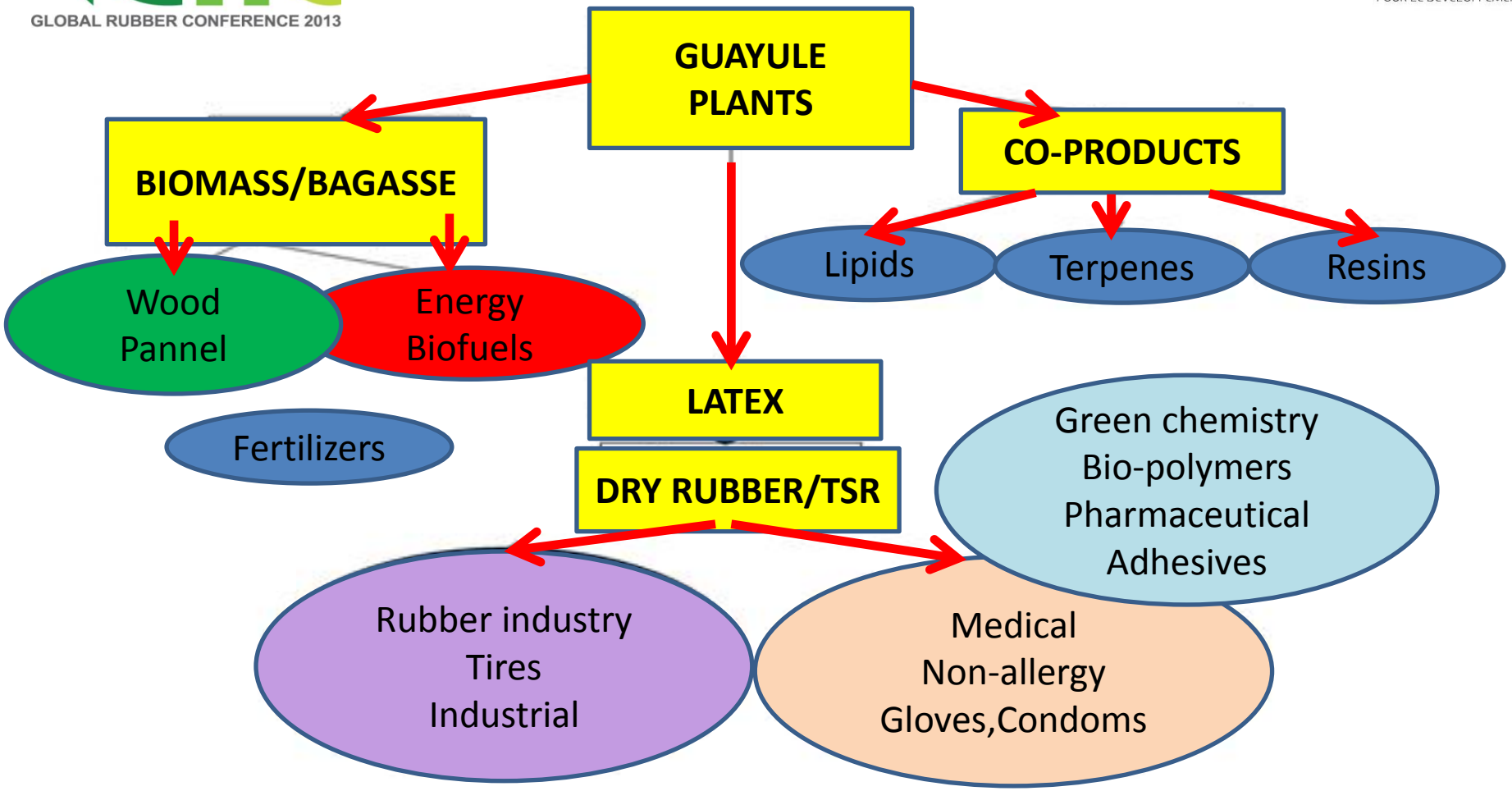
PROPERTIES	GR 1	GR 2	HR
Initial Plasticity P0 , ISO 2007	**13**	**31 - 33**	>30
Plasticity retention indice PRI (ISO 2930)	**15.4**	**6.5- 15.2**	**>40**
Mooney Viscosity ML (1+4) 100° C ISO 289-1	25	52 -53	60-80
Dirt content % ISO 249	-	0.016 0.038	<0.20
Acetone extract ISO 1407	12.4	12 -14	<0.5
Ash content % ISO 247	-	0,19- 1.25	<1.00
Total nitrogen ISO 13878	-	0. 21	<0.60

Balances
hevea and guayule cultivation



Source : Nisrin SHILAMM/CIRAD 2011-2012 with « Olympe » software (for publication)

VALORISATION OF BIOCHEMICALS FOR GUAYULE



R.DANDELION → INULINE → BIOETHANOL

THRESHOLD SELLING PRICE OF GUAYULE RUBBER

Option 1: only Latex (centrifugation)

- With current technology, it is possible to extract 25 % of the total rubber as latex.
  - The valorisation of sole guayule latex woul 60% possible only through a niche market with very high added value.

Option 2: only crude rubber + resin (solvent extraction)

- With current technology, it is possible to extract 90 % of rubber + 95 % of the resin.
  - ✓ (*Prices recorded in 2011*).

Option 3: Latex as step 1, followed by **crude rubber + resin** as step 2.

- It is possible to extract 25 % of latex + 65 % of crude rubber + 95 % of resin.

Threshold selling price (€ /kg) to reach profitability

Option	Latex	Crude rubber	Resin
1. Latex only	8.0-9.0		
2. Solvent only		4,0	3,0
3. Latex, then solvent	5.0	3.0	3.0

CONCLUSION

➢ GUAYULE OR TKS RUBBER NOT A THREAT FOR *HEVEA*

HEVEA NR NOT AVAILABLE, ALTERNATIVE SOURCES WILL DEVELOP. (5000 TONS OF GR & TKS GRADES IN 2025 ?)

➢ COMMERCIAL CONDITIONS FOR PRODUCTION OF GR & TKS NR

- **PRICE OF NR (> 3.0 $US /kg),**
- **HIGHER RUBBER YIELD (≈1 TON/HA),**
- **LOWER COSTS OF PRODUCTION, EFFICIENCY OF PROCESS EXTRACTION**
- **NEW CULTIVARS, GENETIC IMPROVEMENT,**
- **VALORISATION OF BIOPRODUCTS , BIOREFINING**

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CONCLUSION

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- **COMMERCIAL PRODUCTION OF NR ALTERNATIVES SOURCES DEPENDS ON:**

  - **RUBBER PRODUCTION & DEMAND (CHINA, INDIA), economy recovery EU**
  - **MORE COMMERCIAL PLANTS OF GR & TKS**
    PLANT WITH HIGHER CAPACITY & NEW AREAS OF PRODUCTION
  - **TYRES & RUBBER INDUSTRY, NATIONAL&INTERNATIONAL ORGANIZATIONS INVOLVED**
  - **MORE ECONOMIC & FEASABILITY STUDIES (CIRAD paper in progress)**
  - **INTEREST FOR GUAYULE AND TKS IS LIKE RUBBER PRICE**

- **CIRAD (BIOWWOOEB) OPENED TO PARTNERSHIP FOR DEVELOPMENT OF GUAYULE IN INDONESIA, OTHER COUNTRIES**

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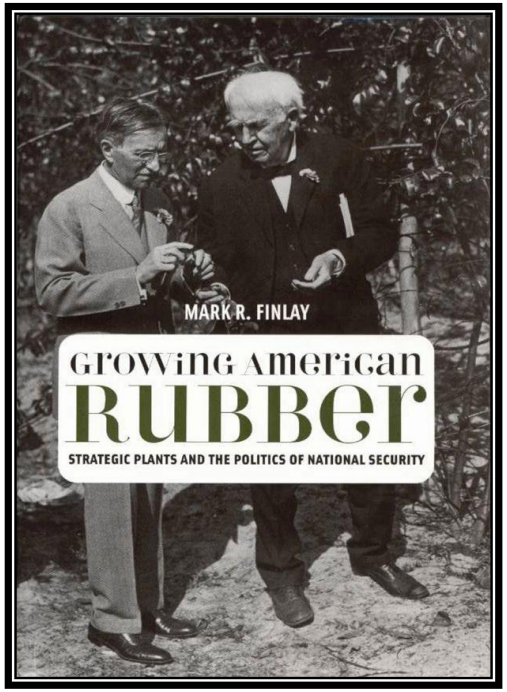
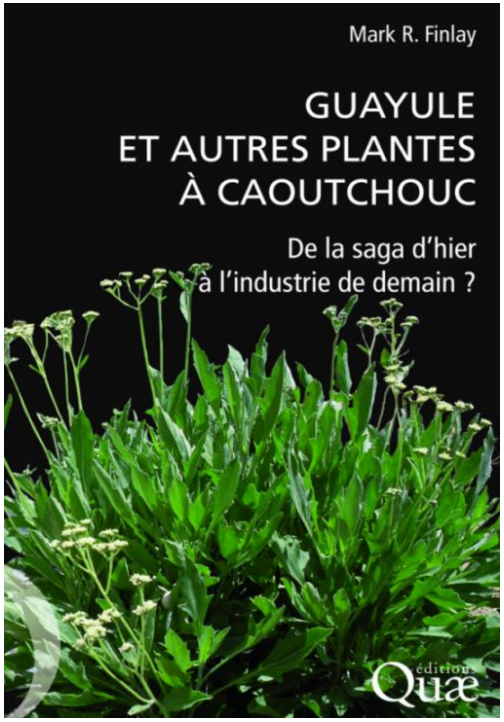
“Catch the alternative Natural Rubber ball”

"Memanfaatkan cadangan gumpalan karet alam”





TERIMA KASIH